

BELLCOMM, INC.

955 L'ENFANT PLAZA NORTH, S.W.

WASHINGTON, D. C. 20024

B71 01030

SUBJECT: Mission Planning Considerations
for an Apollo 15 Walking Traverse
Case 320

DATE: January 25, 1971

FROM: P. Benjamin

ABSTRACT

A possible delay in the LRV delivery may force Apollo 15 to fly on schedule but without the rover, resulting in walking, rather than riding traverses at Hadley-Apennines. The Hadley North landing site was chosen specifically to provide the capability for either riding or walking traverses, and preliminary riding and walking traverses have already been designed for the site. The walking traverses as designed would provide both a backup in case of LRV failure and prime traverses in case of elimination of the LRV from the mission.

A relatively early decision that the LRV would not be available would require:

1. establishing equivalence of backup and prime walking traverses
2. concentration on development of walking traverses
3. a decision on the desirability of TV for science and/or PIO
4. communications line of sight analysis to determine the utility of the LCRU
5. initiation of MET design to accommodate the above hardware, if required
6. information on the effect of the MET on metabolic rate and velocity
7. modification of EVA timelines to delete LRV and include MET deployment
8. switch of emphasis in crew training from LRV and riding traverses to MET and walking traverses
9. preparation of photo maps and traverse aids for walking traverses.

The lead time required to perform these tasks effectively must be determined in order to define a date by which a decision must be made whether or not to fly the LRV. At present hardware development appears to be the critical path, with a decision on MET fabrication required in March. A delayed decision requires dual development of riding and walking missions with increased work loads, greater costs, and probable degradation in final performance.

N79-73353

(NASA-CR-116947) MISSION PLANNING
CONSIDERATIONS FOR AN APOLLO 15 WALKING
TRAVERSE (Bellcomm, Inc.) 6 p

Unclas
00/91 12036

(CATEGORY)

(NASA CR OR TMX OR AD NUMBER)

FF No. 60



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MEMORANDUM FOR FILE

A possible delay in the LRV delivery may force Apollo 15 to fly on schedule but without the rover, resulting in walking, rather than riding traverses at Hadley-Apennines. If late LRV delivery is determined to be a probable event, a decision to switch to a walking mission may be made in the very near future, in which case all planning may be changed to accommodate this, or the decision may be delayed for a number of months, in which case dual planning for both walking and riding traverses must be initiated to provide for either option. A number of decisions and actions are required to plan walking traverses, as summarized in Figure 1 and discussed below. The earlier that planning for walking traverses is initiated the better the final product will be.

The Apollo 15 landing site, Hadley North, was chosen specifically to provide the capability for either riding or walking traverses. All primary objectives can be reached regardless of the mobility mode, although a greater diversity of samples can be obtained by riding. Preliminary riding and walking traverses have already been designed for the site. Both the landing point location and the traverses can be expected to change somewhat between now and flight time due to normal maturation, timeline alterations, flight profile optimizations, and changes in expected systems capabilities. Of course, as long as the mission maintains the status of riding traverses as the primary mode and walking as a backup, it can be expected that most of the attention and effort will be expended in developing LRV traverses, although planning for backup walking traverses to a riding mission is proceeding. Much of the development for riding traverses is applicable directly or with some modifications to walking traverses so that, with continuing development of walking traverses as a backup mode, these could be brought to the same status as riding traverses in a relatively short period of time compared to the development time of the riding traverses. This assumes that the backup walking traverses for an LRV mission and the primary traverses for a walking mission are essentially the same. A more formal agreement from the scientific community that this equivalence is acceptable may be useful.

WALKING TRAVERSESHardware Development

If a decision to fly without the LRV is made relatively early, considerable effort can be applied to optimizing the walking traverses to accommodate the higher metabolic cost and lower velocity of walking. In this case decisions must be made as to the utility of a MET, the LCRU, and the TV. Television is not required for scientific purposes, although it may contribute to the interaction between the crew and ground-based scientists. Television does, however, have considerable PIO value and may be carried for this reason alone. If the TV is not carried the requirement for the LCRU depends upon the attenuating effect of local terrain on astronaut transmissions to the LM. Detailed terrain and communications analysis may determine that the LCRU is not needed for the limited radius of operations of walking astronauts. If the TV and LCRU are carried, the utility of a MET to transport these devices would appear to be clear, and the development of a MET designed to carry this equipment is required. Informal discussions with MSC have revealed that drawings for a MET trainer are almost complete, and fabrication of this model is scheduled to be complete by April. A March decision to construct the flight article should permit June 1 delivery.

The effect of the MET, particularly with the LCRU, on walking velocity, metabolic rates, and fatigue is unknown and may have a significant effect upon traverse planning. Hopefully, some data on these subjects will be obtained from Apollo 14 experience with the MET. If the MET proves to significantly hinder lunar locomotion, either because of the effort required to pull or control it or through limitations on walking velocity, either the walking traverses would have to be curtailed, an alternate mobility aid would be required, or the crew would have to carry all the equipment. Since the load on Apollo 15 is much greater than on the Apollo 14 MET an examination of whether 1 or 2 METs can most efficiently transport the payload is required.

Training and Procedures

The deletion of the LRV impacts crew training, with changes to both the traverses and the EVA timeline. The crew must be trained to deploy and pull the MET, rather than operate the LRV. This may actually result in a time savings, since the MET is easier to deploy and operate than the LRV, and thus should require less training. The later, however, a decision would come to switch from the LRV to the MET, the more time would already have been irretrievably invested in LRV related training. The deployment procedures for the MET would have to be developed and integrated into the timeline. Based upon

past performance, this development should be possible in less than a month, although increased time would result in greater efficiency and finesse.

The success of the field geology investigation depends upon crew familiarity with the traverses and the rationale behind their design. The crew should be able to perform traverses with as little as a week's exposure to them. The scientific return will increase significantly as their familiarity with the geology, geography, station activities, and logic for traverse design is increased. Only based upon their knowledge of the reasons for the placement of stations and selection of samples will the crew be able to make useful real time judgements on sampling strategy. This knowledge is critical to scientific return and is, after all, the primary reason that man, rather than machine, is being sent to the moon. Sufficient lead time must be provided to accommodate crew familiarity with the traverses and the design rationale. The preparation of photomaps and traverse aids requires knowledge of the traverses to be performed. Although these items could be prepared in a relatively short time, their quality increases significantly as more lead time is provided.

DELAYED DECISION

If the decision whether or not to fly the LRV is delayed and provision is made to adopt either the walking or the riding option, all of the activities described above would have to be carried out in addition to those which would normally be required for riding missions. This could be expected to greatly increase the work load of those involved and would reduce the time which could be applied to developing either option, with resultant possible degradations in preparation and performance.

The crew would have to train to deploy and operate the LRV as well as the MET. Two sets of EVA timelines and two sets of traverses with associated rationale would have to be developed in detail and crew training for both would probably result in decreased capability for either. In addition, two sets of photo maps and traverse aides would have to be prepared. Thus a delayed decision would necessitate increased effort, would incur greater expense, and would probably result in a reduced overall capability.

SUMMARY

The current Apollo 15 landing site provides the capability to obtain all primary objectives on either riding or walking traverses. A relatively early decision that the LRV would not be available for the flight would require:

1. establishing equivalence of backup and prime walking traverses
2. concentration on development of walking traverses
3. a decision on the desirability of TV for science and/or PIO
4. communications line of sight analysis to determine the utility of the LCRU
5. initiation of MET design to accommodate the above hardware, if required
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7. modification of EVA timelines to delete LRV and include MET deployment
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9. preparation of photo maps and traverse aids for walking traverses.

The lead time required to perform these tasks effectively must be determined in order to define a date by which a decision must be made whether or not to fly the LRV. Hardware development would appear, at present, to be the critical path, with a decision on MET flight unit fabrication required in March. If the decision is delayed, dual development of walking and riding traverses to provide for both options would result in a large increase in work load for mission planners, greater crew training requirements, and probably degradation in final performance. If walking as an option is to be provided for, a decision to emphasize serious work on walking missions is required.

2032-PB-meh


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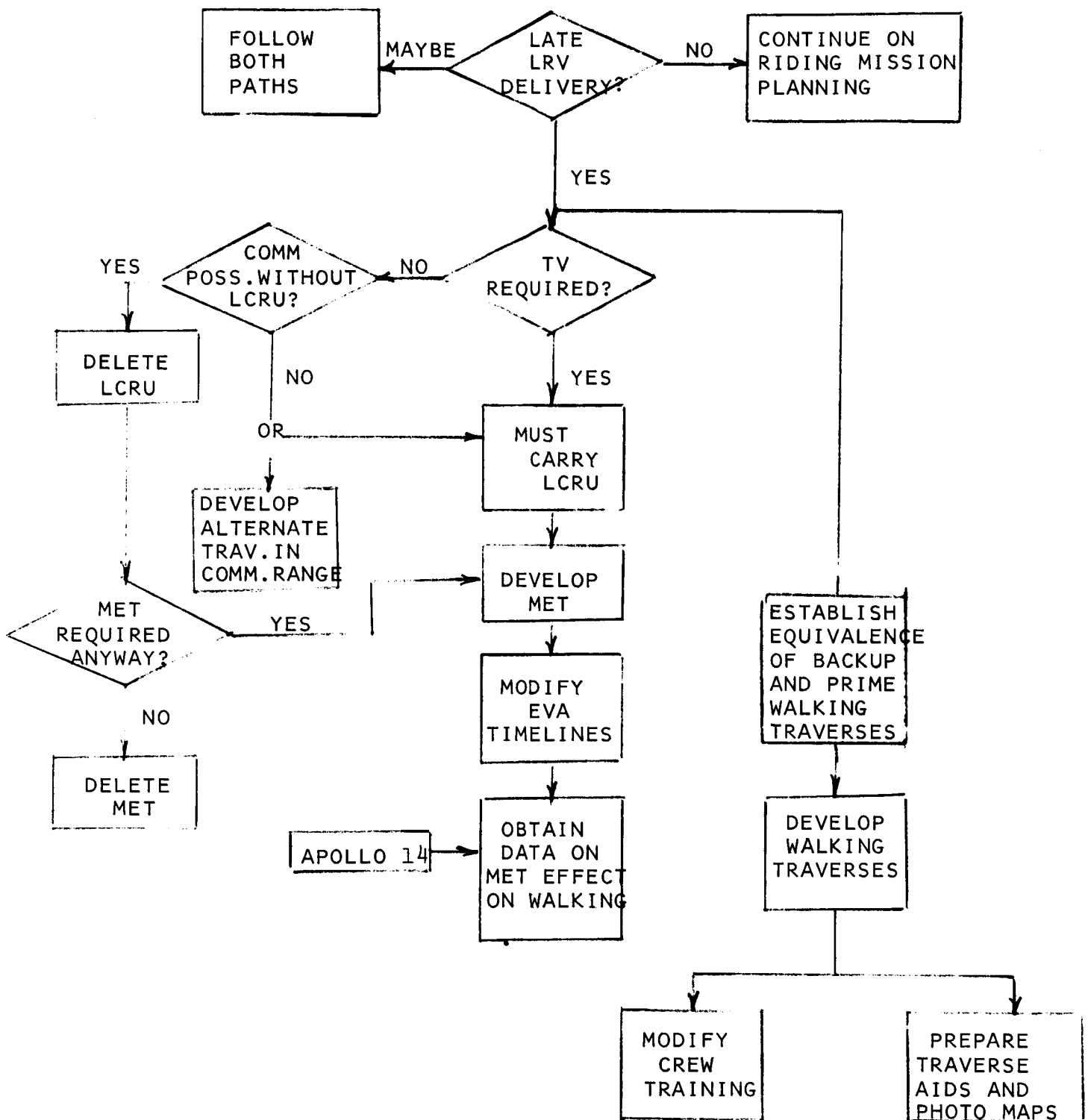


FIGURE 1: WALKING MISSION PLANNING PROCESS

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